VARIABLE AREA FAN EXHAUST NOZZLE HAVING MECHANICALLY SEPARATE SLEEVE AND THRUST REVERSER ACTUATION SYSTEMS

This is a continuation in part of U.S. application Ser. No. 08/572,839, filed Dec. 14, 1995, which in turn is a continuation in part of U.S. application Ser. No. 08/326,621, filed Oct. 20, 1994, now abandoned.

TECHNICAL FIELD

The present invention relates to a gas turbine engine and, more particularly, to a variable area fan exhaust nozzle therefor.

BACKGROUND OF THE INVENTION

Important performance criteria for modern aircraft gas turbine engines include greater thrust, minimization of weight, and reduction in noise levels and fuel consumption. As is well known in the art, a reduction in the fan pressure ratio improves the propulsive efficiency of a gas turbine engine. As the fan pressure ratio is reduced, the mass flow rate through the fan must be increased to maintain the same engine thrust. Longer fan blades increase the mass flow rate. However, reduction of the fan pressure ratio and an increase in the length of the fan blades adversely affect the fan stability. Longer fan blades rotating at lower speeds pump additional air through the fan. At cruise, the additional mass flow at the lower fan pressure ratio contributes to the engine thrust as the air exists through a fan exhaust nozzle disposed downstream of the fan. However, at takeoff, climb, and descent, the additional air is restricted through the fan exhaust nozzle and the resulting back pressure on the fan negatively affects the aerodynamic stability of the fan. Thus, fan stability is a limiting factor to low fan pressure ratio engines.

Varying the pitch of the fan blades is one approach to control fan stability. The pitch of the fan blades changes to tailor the amount of airflow passing through the fan during the different modes of operation of the gas turbine engine. During takeoff, climb and descent, the amount of air pumped by the fan blades is reduced, thereby reducing back pressure and avoiding instability conditions.

Another approach to improve performance of the gas turbine engine is described in U.S. Pat. No. 5,181,676 to Lair, entitled "Thrust Reverser Integrating A Variable Exhaust Area Nozzle". The patent discloses two clam shells that rotate about a pivot upon actuation to increase the exhaust area of the nozzle. A limitation of the disclosed fan nozzle is that only a small increase in the nozzle area is possible without adversely affecting external or internal aerodynamics. Moreover, the nozzle can suffer undesirable leakage of airflow, thereby reducing the performance of the gas turbine engine. Additionally, since the fan exhaust nozzle functions as a pressure vessel, it is subjected to significant internal pressure that tends to deform each clam shell, since they are supported only at discrete points. The clam shell, as disclosed in the above-mentioned patent, must carry a significant weight penalty to control such deformation of the fan exhaust nozzle.

U.S. Pat. No. 4,922,713 to Barbarin et al shows a thrust reverser with a variable exhaust cross section. The patent discloses a translating cowl moving downstream to open an auxiliary passageway, thereby increasing the area available for discharging gases from the exhaust nozzle. However, the disclosed invention is not suitable for low pressure ratio

fans, because the actuation system of the disclosed configuration is limited to a sequence of operations which, for low pressure ratio fan designs, will cause instability of the fan during transition to reverse thrust. The configuration dictates that the translating cowl must be stowed prior to activation of the thrust reverser. For low pressure ratio fans, the reduction in the fan nozzle area will be detrimental to stability and will result in stalling of the fan.

Furthermore, the described configuration has significant aerodynamic and acoustic limitations. The disclosed configuration has an adverse impact on an aerodynamic efficiency of both the overall aircraft and the propulsion system. The adverse effect to the aircraft is two-fold. At high speed operations, the radial velocity component due to the auxiliary nozzle flow is a potential safety hazard because of its detrimental effect on flow as it approaches the wing. At low speed operations, the radial velocity component disturbs airflow around the wing degrading lift at low speeds and thereby degrading the performance of the aircraft.

The auxiliary airflow path of the disclosed configuration adversely affects the propulsion system by introducing three aerodynamic performance loss mechanisms: shock losses produced by supersonic turning; increasing pressure drag; and increased friction losses.

Moreover, the disclosed configuration negatively impacts internal aerodynamic performance by incorporating struts that span the auxiliary airflow path. The struts reduce the aerodynamic performance of the internal flow path and also increases the scrubbing drag and pressure drag of the internal flow.

Additionally, the disclosed configuration significantly degrades acoustic performance of the aircraft because the auxiliary nozzle introduces multiple noise sources.

Another major shortcoming of the U.S. Pat. No. 4,922,713 is that the second moveable cowl, once translated to the maximum area position, must be retracted prior to entering the reverse thrust mode so that the second moveable cowl can be locked to the first moveable cowl. Thus, any malfunction which prevents retraction of the second moveable cowl will prevent deployment of the thrust reverser.

There is still a great need to provide a high performance gas turbine engine having minimized weight, lower noise, and lower fuel consumption levels without jeopardizing other performance characteristics thereof.

DISCLOSURE OF THE INVENTION

According to the present invention, a gas turbine engine having a core engine enclosed in a conical core cowl and an aerodynamically contoured outer nacelle with the outer nacelle being disposed radially outwardly of the core cowl and spaced apart therefrom and defining a duct therebetween, includes a translating sleeve disposed in the downstream portion of the outer nacelle to increase the effective throat area of the fan exhaust nozzle as the translating sleeve translates axially downstream and cooperates with a decreasing downstream diameter of the conical core cowl. The fan exhaust nozzle throat is defined between the trailing edge of the translating sleeve and the core cowl. The translating sleeve comprises an aerodynamically-shaped body and a plurality of actuating means moving the translating sleeve from a fully stowed position axially downstream into a fully deployed position during climb, takeoff, and descent. The translating sleeve is also capable of having a plurality of intermediate deployed positions.

The variable area fan exhaust nozzle allows gas turbine engines to have higher efficiency at cruise without adversely